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Evolution of a neutron-initiated micro big bang in superfluid He 3 -B

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Abstract

A nuclear capture reaction of a single neutron by ultracold superfluid He3 results in a rapid overheating followed by the expansion and subsequent cooling of the hot subregion, in a certain analogy with the big bang of the early universe. It was shown in a Grenoble experiment that a significant part of the energy released during the nuclear reaction was not converted into heat even after several seconds. It was thought that the missing energy was stored in a tangle of quantized vortex lines. This explanation, however, contradicts the expected lifetime of a bulk vortex tangle, 10-5-10-4 s, which is much shorter than the observed time delay of seconds. In this paper we propose a scenario that resolves the contradiction: the vortex tangle, created by the hot spot, emits isolated vortex loops that take with them a significant part of the tangle's energy. These loops quickly reach the container walls. The dilute ensemble of vortex loops attached to the walls can survive for a long time, while the remaining bulk vortex tangle decays quickly.

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